(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 698 684 A1

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**28.02.1996 Bulletin 1996/09**

(51) Int. Cl.[6]: **D21G 1/02**, F16C 13/00

(21) Application number: **95111693.8**

(22) Date of filing: **25.07.1995**

(84) Designated Contracting States:
**AT DE FR GB IT SE**

(30) Priority: **04.08.1994 FI 943620**

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## (54) Variable crown roll, loaded by means of shoes

(57) The invention concerns a variable-crown roll loaded by means of shoes, comprising a stationary roll axle (12), around which a tubular roll mantle (11) is fitted revolving, which roll mantle is mounted by its ends on the roll axle (12) by means of end bearings (13a,13b). Hydraulic loading shoes ($15_1$...$15_n$) are fitted between the roll mantle (11) and the roll axle (12), which shoes act upon the inner face of the roll mantle (11) in the nip plane and are supported on the roll axle (12) and which shoes are loaded by means of a hydraulic pressure medium, and the nip pressure can be profiled in the axial direction of the roll (10) by regulating the pressure of the pressure medium passed into said loading shoes. The roll mantle (11) is made of a fibre-reinforced composite material so that the stability of shape of the roll mantle (11) in the direction of the circumference is good and the rigidity in the axial direction is low.

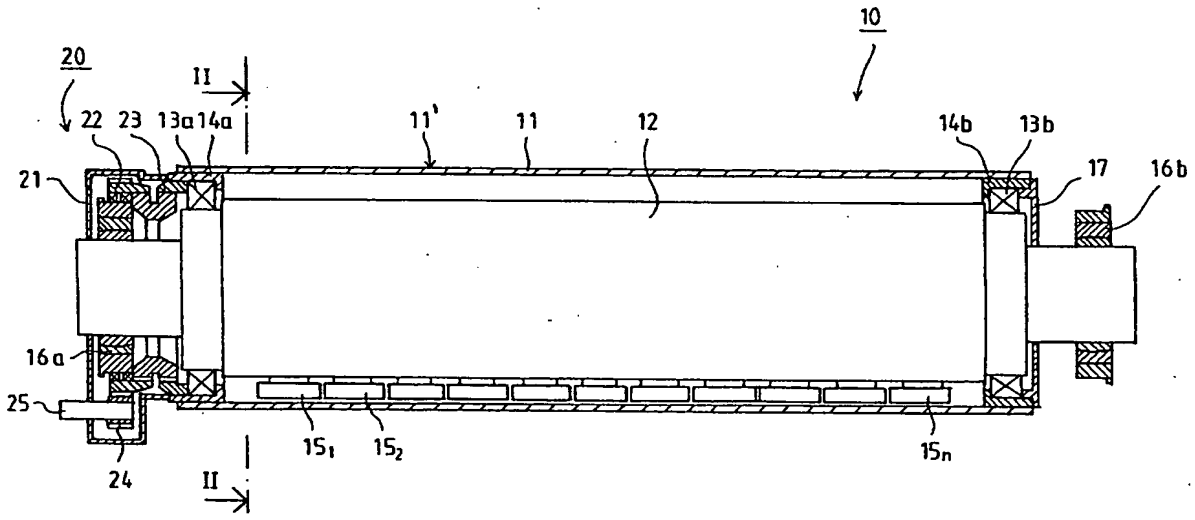


FIG. 1

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## Description

The invention concerns a variable-crown roll loaded by means of shoes, comprising a stationary roll axle, around which a tubular roll mantle is fitted revolving, which roll mantle is mounted by its ends on the roll axle by means of end bearings, hydraulic loading shoes being fitted between the roll mantle and the roll axle, which shoes act upon the inner face of the roll mantle in the nip plane and are supported on the roll axle and which shoes are loaded by means of a hydraulic pressure medium, and the nip pressure can be profiled in the axial direction of the roll by regulating the pressure of the pressure medium passed into said loading shoes.

From a variable-crown roll loaded by means of shoes, and in particular from the mantle of such a roll, different properties are required in the direction of the circumference of the mantle and in the direction of the roll axle. Variable-crown rolls are used commonly as nip rolls, and in such a case the shape of the mantle must remain unchanged even at high nip loads. However, in cases in which the nip pressure is supposed to be profiled in the direction of the roll axle, the rigidity of the roll mantle in the axial direction must be low. Conventional variable-crown rolls are thick-mantle steel rolls, in which case the profiling of the nip pressures requires very high forces applied to the roll mantle. This is why, in certain cases, it would be advantageous if the roll mantle could be made thinner. The technique of manufacture that is in use currently, however, restricts a reduction of the thickness of the steel mantles. A second problem involved in the prior-art variable-crown rolls is the high weight of the thick roll mantle and the drawbacks resulting from this weight. It is a significant drawback arising from the weight of the roll mantle that the properties of oscillation of the roll mantle are poor.

The object of the present invention is to provide a variable-crown roll loaded by means of shoes that is of a novel type, by means of which roll some of the drawbacks involved in the prior-art solutions are avoided and by whose means, in a number of applications, a remarkable improvement is achieved in comparison to the prior-art solutions. In view of achieving this, the invention is mainly characterized in that the roll mantle is made of a fibre-reinforced composite material so that the stability of shape of the roll mantle in the direction of the circumference is good and the rigidity in the axial direction is low.

By means of the invention, compared with the prior art, a number of advantages are obtained, of which, for example, the following should be stated herein. First, the roll in accordance with the present invention excellently meets the requirement that the nip pressures can be profiled in the axial direction in the desired way, at the same time as the shape of the roll mantle in the direction of the circumference remains unchanged even with high loads. This property has been obtained by means of a suitable choice of the material, because, when the roll mantle is made of a fibre-reinforced composite material, the desired properties are obtained for the roll mantle, for example, by means of alignment of the reinforcement fibres and by means of the choice of the reinforcement materials. Compared with the prior art, it is a highly remarkable further advantage of the invention that the properties of oscillation of the roll are significantly better than in the prior art, because, in the present invention, the weight of the roll mantle is just a fraction of the weight of a conventional steel mantle. It is a further advantage of the roll mantle of a roll in accordance with the present invention that the inner face of the mantle does not have to be machined, because the shape of the inner face of the roll mantle, i.e. its cylindrical and circular shape and the quality of the surface of the inner face, are automatically good in order that the mantle could be detached from its mould at all. The favourableness of the present invention is manifested best as the back-up roll of an extended-nip press, because in said application, compared with a normal nip, a lower surface pressure is applied to the roll mantle over a wider area. Of course, a roll in accordance with the invention can also be used as an ordinary nip roll. The further advantages and characteristic features of the invention will come out from the following detailed description of the invention.

In the following, the invention will be described by way of example with reference to the figures in the accompanying drawing.

Figure 1 is a schematic vertical axial sectional view of a roll in accordance with the invention.

Figure 2 is a schematic sectional view of the roll in accordance with the invention taken along the line II-II in Fig. 1.

Figure 3 is a schematic sectional view of an application of the roll shown in Fig. 2 as a nip roll.

Figure 4 is a schematic sectional view of an application of a roll in accordance with the invention as a back-up roll in an extended-nip press.

Figure 5 is a schematic sectional view of an application of a roll in accordance with the invention as a back-up roll in an extended-nip press, which press is provided with two press felts.

Figure 6 shows a preferred embodiment of the hydraulic diagram when the roll in accordance with the invention is used as the back-up roll of an extended-nip press.

In the illustrations in the drawing, the roll in accordance with the invention is denoted generally with the reference numeral 10. As is shown in Fig. 1, the roll 10 comprises a tubular roll mantle 11, which is mounted revolving on the roll axle 12 by means of end bearings 13a,13b. Between the end bearings 13a,13b of the roll and the roll mantle 11, support rings 14a,14b have been fitted, by whose means the roll mantle 11 is supported on the end bearings 13a,13b. On the roll axle 12, loading shoes $15_1 ... 15_n$ have been fitted, which are loaded by means of a hydraulic pressure medium and which are supported against the inner face of the roll mantle 11. The roll axle 12 is mounted by means of articulated bear-

ings 16a,16b on the frame of the paper machine or on an equivalent frame member.

As is illustrated in Fig. 1 and also in Fig. 2, the thickness of the roll mantle 11 is very little, compared with conventional variable-crown rolls with steel mantles. The roll mantle 11 is made of a fibre-reinforced composite material, for example, by means of a normal manufacturing technique by winding onto a mandrel. In the material, preferably a continuous fibre is employed, which is aligned in the desired way to provide the desired properties. By means of alignment of the reinforcement fibres and choice of the reinforcement materials, the desired properties are provided in the different directions. As was already stated above, the shape of the roll mantle must remain unchanged in the direction of the circumference even at high loads, whereas the rigidity of the mantle in the axial direction should be low in order that the nip pressures could be profiled in the axial direction. By means of an orientation of the fibres in the direction of the circumference of the roll mantle in the composite material of the roll mantle 11, the roll mantle 11 can be made rigid in the direction of the circumference, in which case, correspondingly, the rigidity in the direction of the roll axle 10 remains lower. However, in practice the fibres cannot be aligned fully in the direction of the circumference, but, in view of successful manufacture of the roll mantle, the alignments of the reinforcement fibres must be made at an angle of ± 5...25° in relation to the direction of the circumference. As the composite material of the roll mantle 11, preferably carbon-fibre reinforced epoxy is used, even though other, alternative materials are also possible. As examples of such other alternative materials should be mentioned, for example, that, as the matrix of the composite material, it is possible to use, e.g., some metal, such as aluminum.

The outer face 11' of the roll mantle can be coated in a way similar to steel faces. Thus, the outer face 11' of the roll mantle can be provided, for example, with an elastomer or rubber coating when the roll is used in the way of an ordinary nip roll, also when a felt runs between the roll mantle and the paper web. In particular when a roll 10 in accordance with the invention is used as a back-up roll of an extended-nip press in a single-felt extended-nip press in which the paper web enters into direct contact with the roll, the outer face 11' of the roll mantle must be provided with a coating that adheres to the paper web, on the one hand, and is well separated from the paper web, on the other hand. In such a case, it is favourably possible to use a ceramic coating as the material of the coating.

The roll 10 as shown in Fig. 1 is provided with a drive gear 20. As such, the roll is particularly well suitable for use as a back-up roll in an extended-nip press. Since the material of the roll mantle 11 differs from conventional steel rolls in respect of its properties of strength and rigidity, the drive gear cannot be attached directly to the roll mantle 11 itself. Thus, the driven cogwheel 22 of the drive gear 20 is attached to the support ring 14a of the end bearing 13a of the roll by means of a support 23. In the other respects, the drive gear 20 involves conventional technology so that the driving cogwheel 24 mounted on the drive shaft 25 is in gear engagement with the driven cogwheel 22. The housing of the drive gear is denoted with the reference numeral 21 in Fig. 1. The opposite end of the roll 10 is provided with a roll end 17 attached to the support ring 14b of the end bearing 13b.

Figs. 2 and 3 are vertical sectional views of the roll 10 in accordance with the invention, and in these figures, similarly to Fig. 1, the roll is denoted with the reference numeral 10, the roll mantle with the reference numeral 11, the roll axle with the reference numeral 12, and the loading shoes with the reference numeral 15. In the case shown in Fig. 3, the roll 10 operates as a nip roll, so that it forms a nip N with the back-up roll 29. A felt F, guided by alignment rolls 28,29, runs through the nip N. As was already described earlier, in the case of Fig. 3, the outer face 11' of the roll mantle is preferably provided with an elastomer or rubber coating.

Fig. 4 illustrates a case in which a roll 10 in accordance with the invention is used as the back-up roll in an extended-nip press. For the roll 10, the same reference denotations are used as, for example, in Figs. 2 and 3. In Fig. 4, the extended-nip press roll is denoted with the reference numeral 30. In the normal way, the extended-nip press roll 30 comprises a glide-belt mantle 31 passed around a stationary axle 32 and loading members 35 or equivalent loading shoes, which are fitted on the axle 32 and which are loaded by means of a hydraulic pressure medium against the inner face of the glide-belt mantle 31 towards the nip N. The loading members or the equivalent loading shoes 35 in the extended-nip press roll 30 are shaped so that their outer faces are concave outwards in the way shown in Fig. 4, so that, owing to this, an extended nip N is provided as the glide-belt mantle 31 follows along the concave outer faces of the loading shoes 35. The extended-nip press shown in Fig. 4 is a single-felt press, in which the paper web W is passed into the nip N on support of the press felt F. After the nip N, the press felt F is passed, when guided by the alignment rolls 36, as a loop around the extended-nip press roll 30. Since the extended-nip press shown in Fig. 4 is a single-felt press, in which the paper web W enters into direct contact with the roll mantle 11 of the roll 10 in accordance with the invention, the outer face 11' of the roll mantle is preferably provided with a coating which adheres to the paper web W well, so that the paper web W can be made to run, after the nip N, over a certain distance along the outer face 11' of the roll mantle. Further, the coating must be such that the paper web W is separated readily from the outer face 11' of the roll mantle at the desired point, so that the paper web W can be separated from the outer face 11' of the roll mantle readily by means of a guide roll 37 to be passed onto the drying wire 38. In Fig. 4, the reversing roll of the drying wire 38 is denoted with the reference numeral 39. Thus, in the outer face 11' of the roll mantle, it is preferable to use, for example, a ceramic coating.

Fig. 5 shows an embodiment in which the roll 10 in accordance with the invention is used in a twin-felt extended-nip press as the back-up roll of the extended-nip press roll 30. For the roll 10 and for the extended-nip press roll 30, the same reference numerals are used as in Fig. 4. Thus, the extended-nip press shown in Fig. 5 is a twin-felt press, in which the press felts $F_1$ and $F_2$ have been passed through the extended nip N while guided by the alignment rolls 36a,36b,36c and 36d. Thus, the paper web (not shown) that is passed into the nip N runs through the nip N between the press felts $F_1$ and $F_2$. Also in such a case, as was already described earlier, it is preferable that the outer face 11' of the roll mantle of the roll 10 in accordance with the invention is provided with an elastomer coating or an equivalent rubber coating.

Finally, Fig. 6 shows a preferred embodiment of the hydraulic diagram when the roll 10 in accordance with the invention is used as the back-up roll of an extended-nip press roll 30. In Fig. 6, the roll in accordance with the invention that operates as the back-up roll in the extended-nip press is denoted with the reference numeral 10, and, as was described earlier, said roll 10 comprises a stationary roll axle 12, onto which a roll mantle 11 has been arranged revolving, which roll mantle 11 is loaded towards the nip by means of loading shoes $15_1...15_n$ supported on the roll axle 12. Similarly, the extended-nip press roll is denoted with the reference numeral 30. The extended-nip press roll 30 comprises a stationary roll axle 32, on which a glide-belt mantle 31 is fitted, which is mounted on the axle 32 by means of end bearings 33a,33b. As was described earlier, the extended-nip press roll 30 is provided with loading members $35_1...35_n$ or equivalent loading shoes, which are supported on the axle 32 and by whose means the glide-belt mantle 31 is loaded towards the nip. Both the loading shoes $15_1...15_n$ in the roll 10 of the present invention and the loading members $35_1...35_n$ in the extended-nip press roll 30 are loaded hydraulically.

For the purpose of loading the nip, the extended-nip press is provided with a hydraulic system which comprises a tank 40 for the hydraulic medium, from which the hydraulic pump 41 takes the hydraulic pressure medium and feeds said medium to the loading shoes $15_1...15_n$ of the roll 10 that operates as the back-up roll and to the loading members $35_1...35_n$ of the extended-nip press roll 30. In the system shown in Fig. 6, the pressure medium supplied by the hydraulic pump 41 is passed from the pressure pipe 42 to the regulation valves $43_1...43_n$ and from these regulation valves along the pressure ducts $44_1...44_n$ to the loading shoes of each roll. Further, from each roll, in the normal way, a return pipe 45 is passed back into the tank 40. The hydraulic system differs from the hydraulic systems of ordinary extended-nip presses so that the loading shoes $15_1...15_n$,$35_1...35_n$ placed at both sides of the nip at corresponding locations are controlled by means of the same regulation valve $43_1...43_n$. Thus, the pressure ducts $44_1...44_n$ coming from the regulation valves $43_1...43_n$ are branched to the two rolls 10,30. Thus, the system of regulation of the hydraulic system is simpler than in the prior-art solutions, and this has been achieved in particularly because the roll mantle 11 of the roll 10 in accordance with the invention is of low weight and can be profiled readily, as was already described above. In order that the regulation of the nip could be carried out successfully in the way described above, it is additionally essential that the areas of the loading shoes $15_1...15_n$ and $35_1...35_n$ placed at opposite sides of the nip are equally large, in which case, when the same pressure is passed to these loading shoes at both sides of the nip, the nip is loaded with equal forces from both sides of the nip.

Above, the invention has been described by way of example with reference to the figures in the accompanying drawing. The invention is, however, not confined to the exemplifying embodiments shown in the figures in the drawing alone, but the invention can be varied and modified within the scope of the inventive idea defined in the accompanying patent claims.

The invention concerns a variable-crown roll loaded by means of shoes, comprising a stationary roll axle (12), around which a tubular roll mantle (11) is fitted revolving, which roll mantle is mounted by its ends on the roll axle (12) by means of end bearings (13a,13b). Hydraulic loading shoes ($15_1...15_n$) are fitted between the roll mantle (11) and the roll axle (12), which shoes act upon the inner face of the roll mantle (11) in the nip plane and are supported on the roll axle (12) and which shoes are loaded by means of a hydraulic pressure medium, and the nip pressure can be profiled in the axial direction of the roll (10) by regulating the pressure of the pressure medium passed into said loading shoes. The roll mantle (11) is made of a fibre-reinforced composite material so that the stability of shape of the roll mantle (11) in the direction of the circumference is good and the rigidity in the axial direction is low.

## Claims

1. A variable-crown roll loaded by means of shoes, comprising a stationary roll axle (12), around which a tubular roll mantle (11) is fitted revolving, which roll mantle is mounted by its ends on the roll axle (12) by means of end bearings (13a, 13b), hydraulic loading shoes ($15_1...15_n$) being fitted between the roll mantle (11) and the roll axle (12), which shoes act upon the inner face of the roll mantle (11) in the nip plane and are supported on the roll axle (12) and which shoes are loaded by means of a hydraulic pressure medium, and the nip pressure can be profiled in the axial direction of the roll (10) by regulating the pressure of the pressure medium passed into said loading shoes, **characterized** in that the roll mantle (11) is made of a fibre-reinforced composite material so that the stability of shape of the roll mantle (11) in the direction of the circumference is good and the rigidity in the axial direction is low.

2. A roll as claimed in claim 1, **characterized** in that the reinforcement fibre of the fibre-reinforced composite material of the roll mantle (11) consists of continuous fibre.

3. A roll as claimed in claim 1 or 2, **characterized** in that the reinforcement fibres in the fibre-reinforced composite material of the roll mantle (11) are oriented at a little angle in relation to the direction of the circumference of the roll mantle (11).

4. A roll as claimed in claim 3, **characterized** in that the reinforcement fibres in the composite material are oriented at an angle of ± 5...25° in relation to the direction of the circumference of the roll mantle (11).

5. A roll as claimed in any of the preceding claims, **characterized** in that the composite material of the roll mantle (11) consists of a combination in which the reinforcement fibre is carbon fibre and the matrix material is epoxy.

6. A roll as claimed in any of the claims 1 to 4, **characterized** in that the matrix material in the composite material of the roll mantle (11) is a low-weight metal material, such as aluminum or equivalent.

7. A roll as claimed in any of the preceding claims, **characterized** in that the outer face (11') of the roll mantle is provided with a coating.

8. A roll as claimed in claim 7, **characterized** in that the coating is an elastic coating, such as an elastomer coating, rubber coating, or equivalent.

9. A roll as claimed in claim 7, **characterized** in that the coating consists of a material whose properties of adhesion to the paper web (W) and properties of separation from the paper web, respectively, are good, in particular of a ceramic material.

10. A roll as claimed in any of the preceding claims, **characterized** in that the roll (10) is the back-up roll of an extended-nip press, which roll forms an extended nip (N) with an extended-nip press roll (30).

11. A roll as claimed in any of the preceding claims, **characterized** in that the roll (10) is provided with a drive gear (20).

12. A roll as claimed in claim 10, **characterized** in that, in operation in an extended-nip press, the hydraulic loading shoes ($15_1$...$15_n$) of the roll are controlled by means of the same regulation valves ($43_1$...$43_n$) as control the hydraulic loading members ($35_1$...$35_n$) placed at a corresponding location in the extended-nip press roll (30) at the opposite side of the nip (N), so that the same pressure has been fed to opposite sides of the nip (N) to be effective at the same axial location.

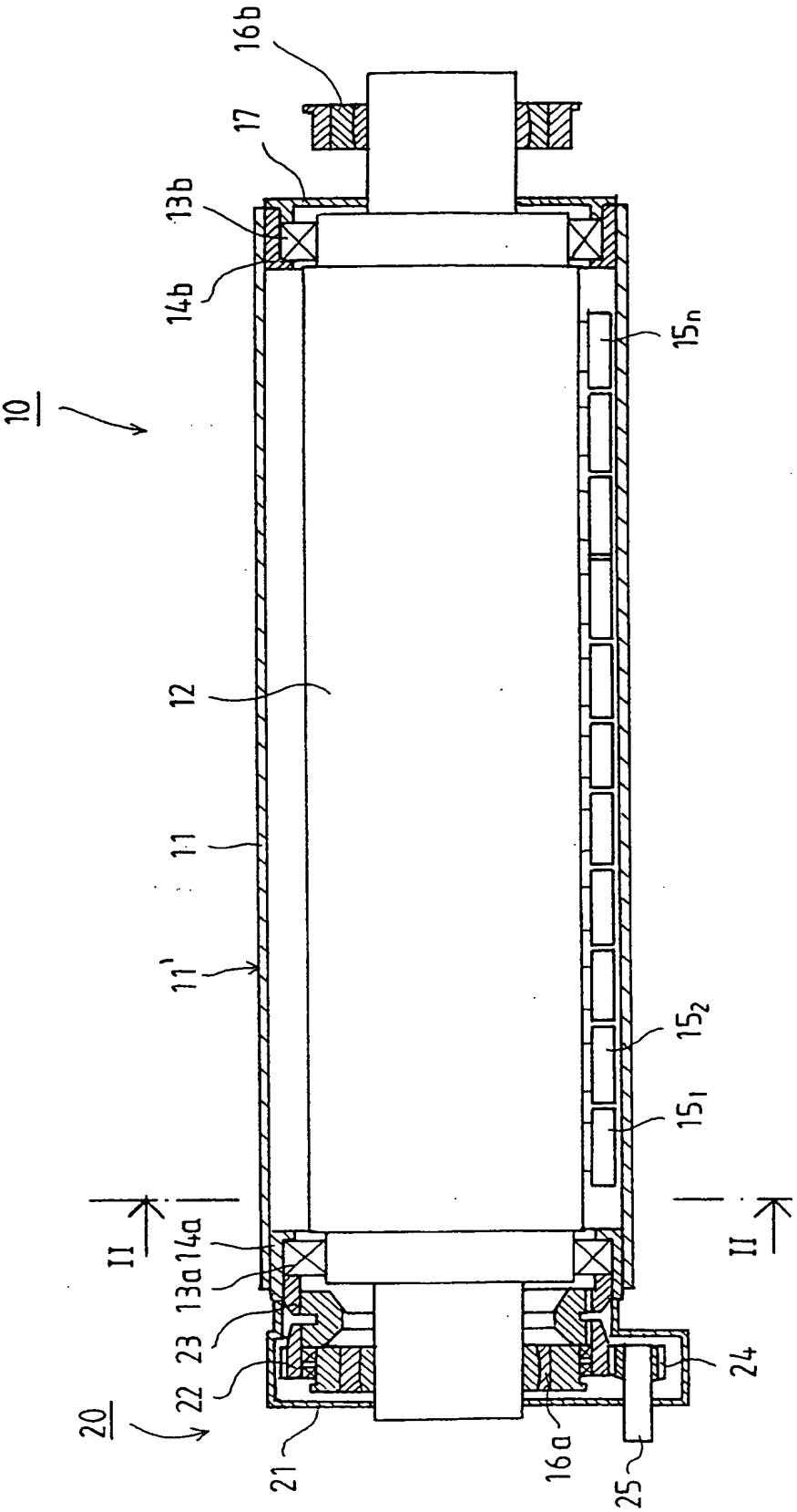


FIG.1

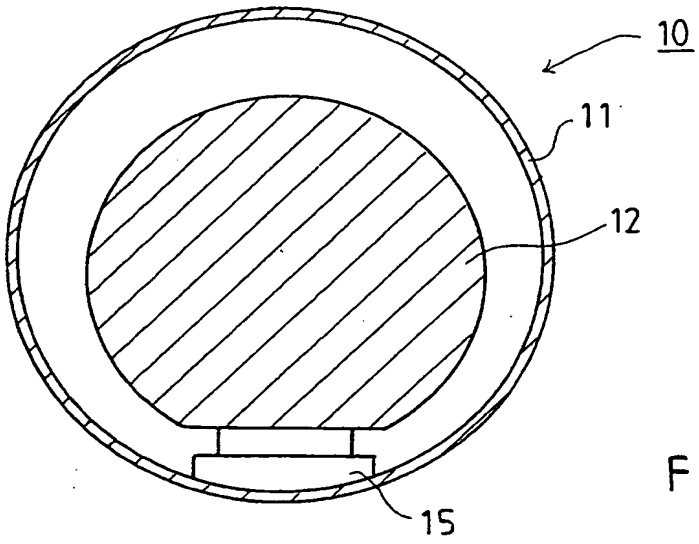


FIG. 2

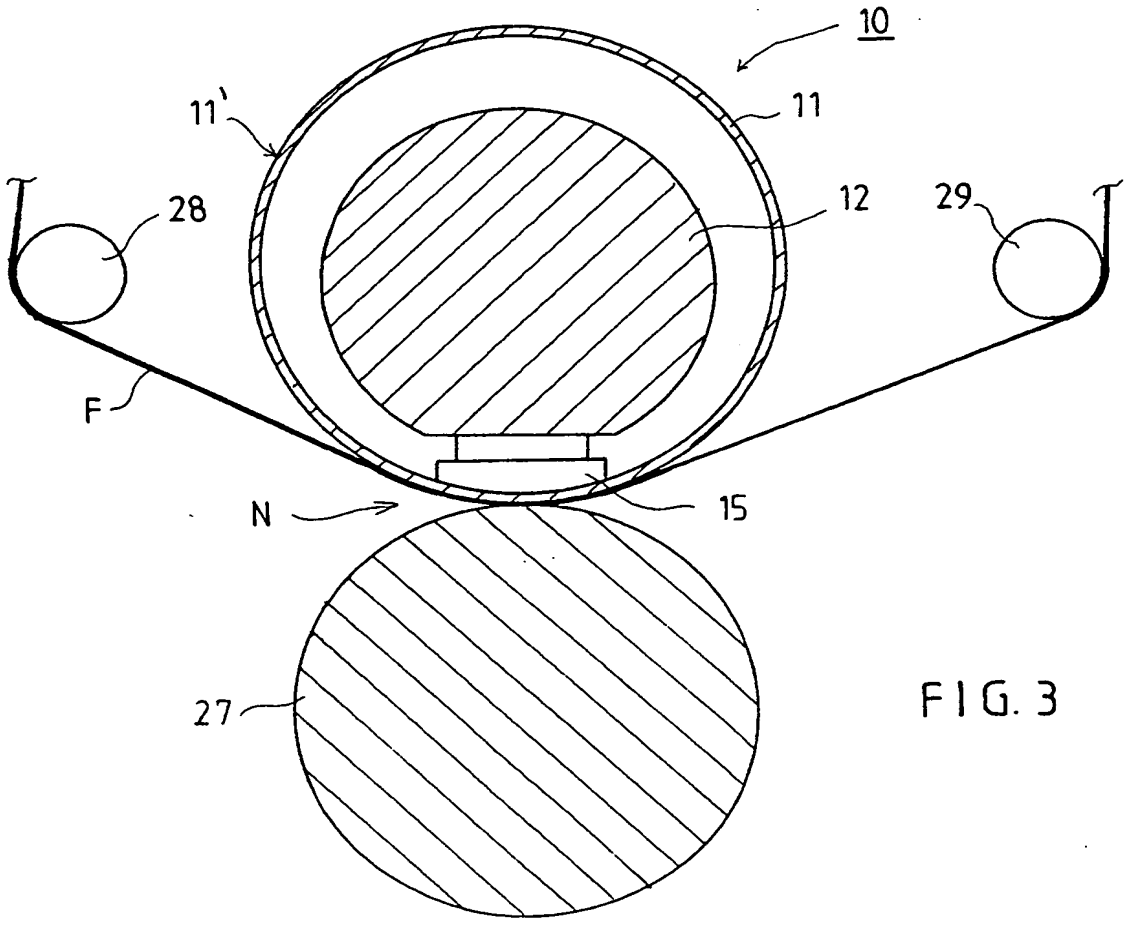


FIG. 3

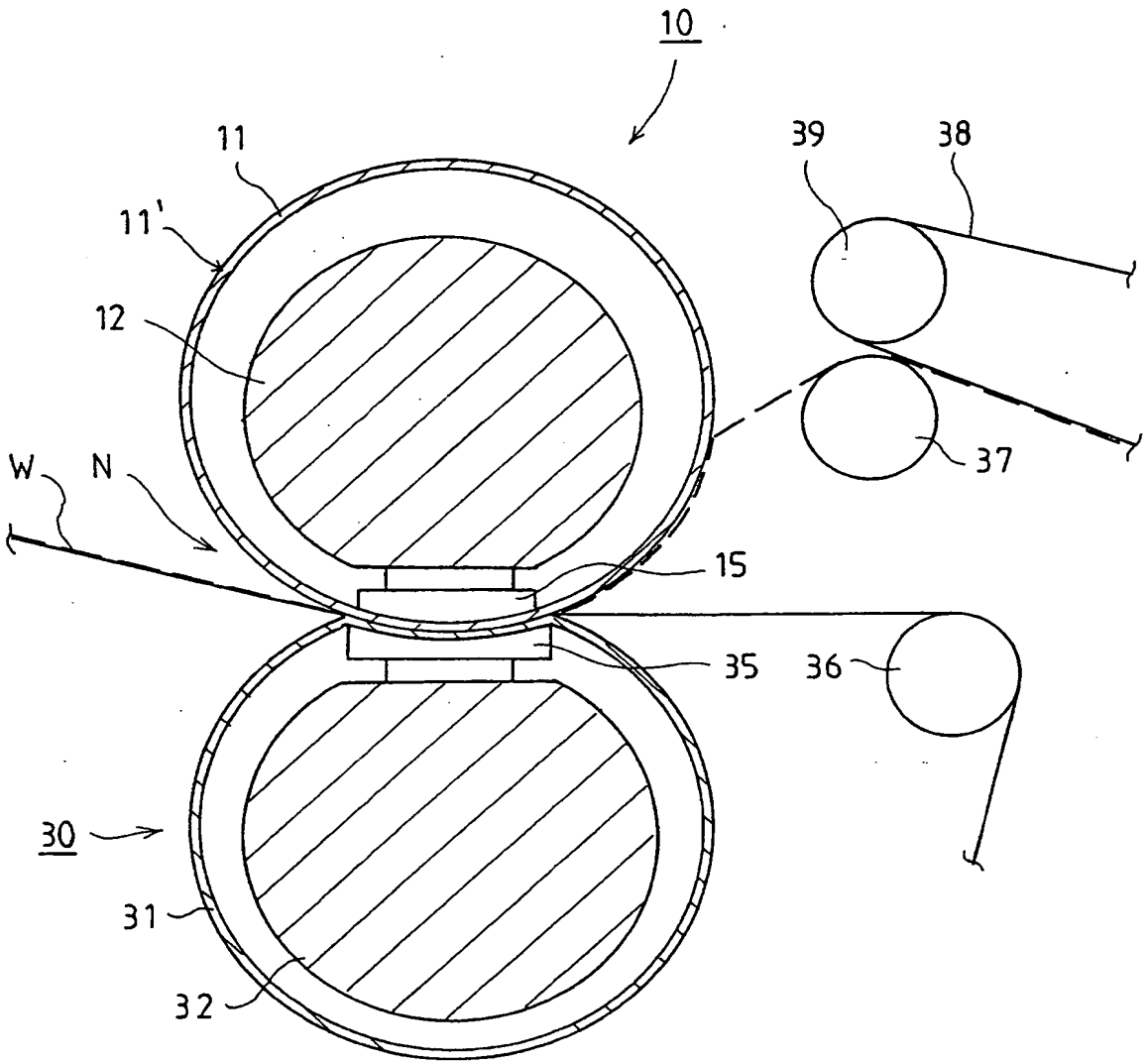


FIG. 4

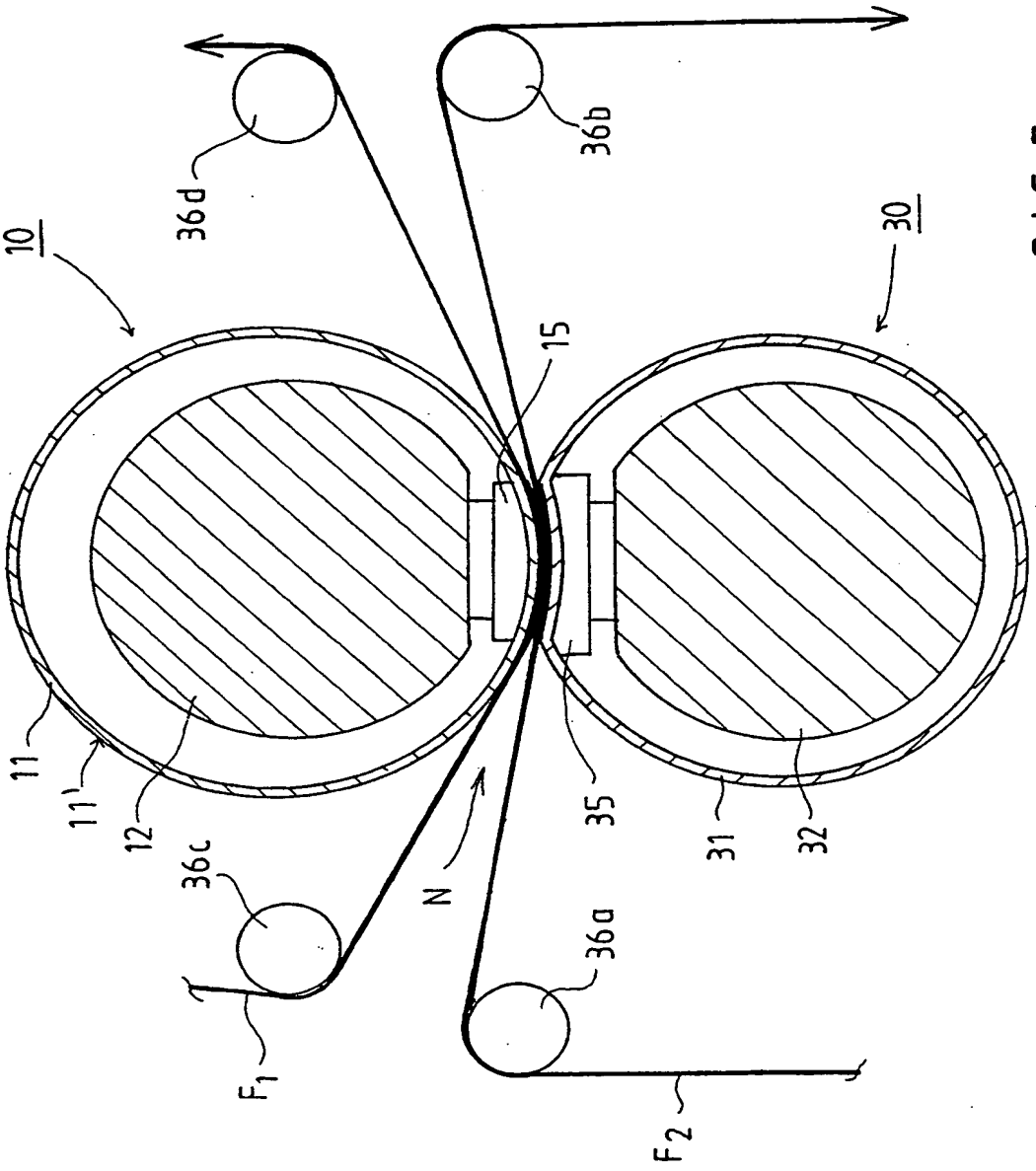


FIG. 5

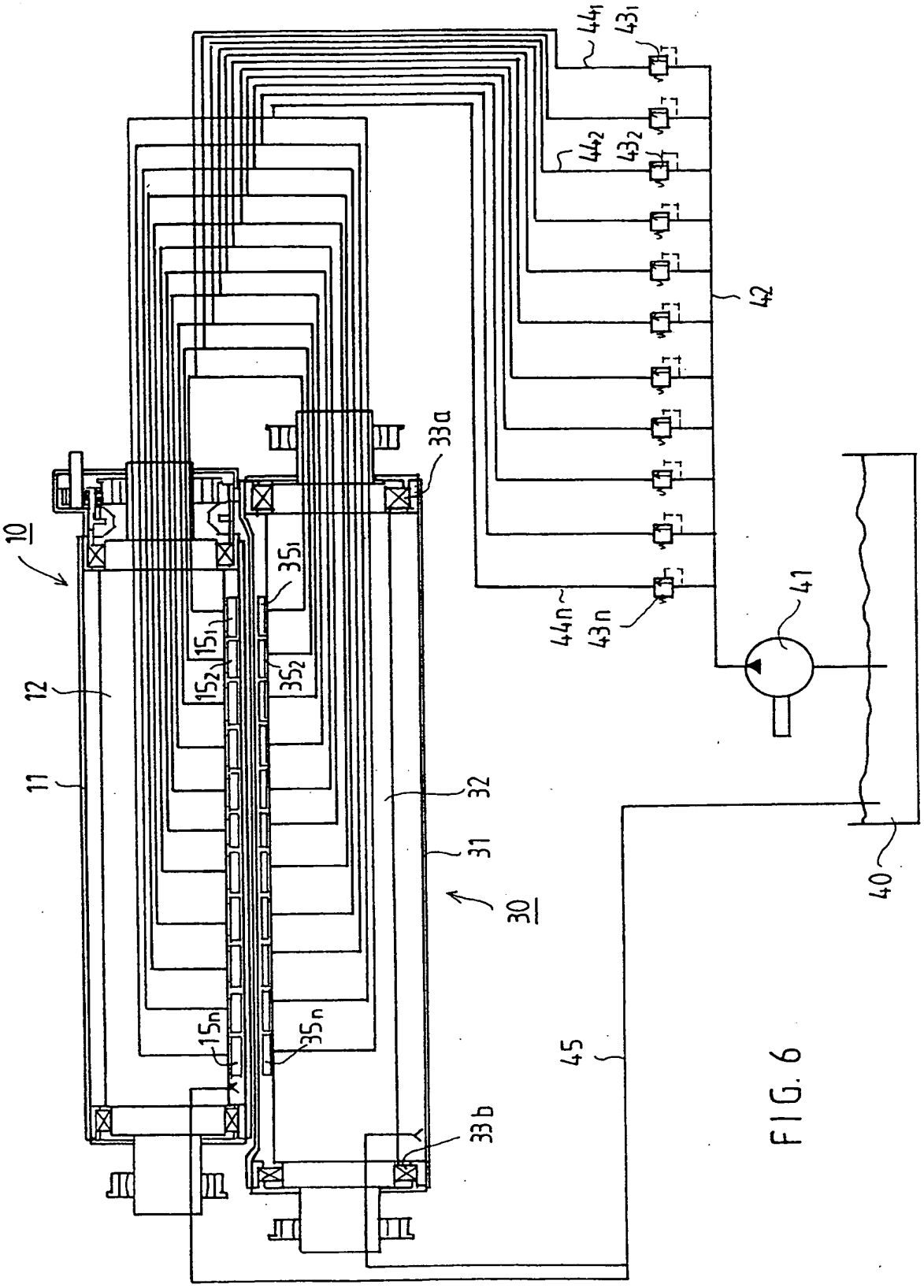


FIG. 6

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# EUROPEAN SEARCH REPORT

Application Number
EP 95 11 1693

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| Y | WO-A-92 13787 (EDUARD KÜSTERS)<br>* the whole document * | 1-8 | D21G1/02<br>F16C13/00 |
| Y | DE-A-25 22 657 (CONTINENTAL GUMMI-WERKE)<br>* the whole document * | 1-8 | |
| A | DE-A-42 17 737 (EDUARD KÜSTERS) | | |

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

D21G
F16C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 8 December 1995 | De Rijck, F |

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